PCT/NZ98/00098

INTELLECTUAL
PROPERTY
OFFICE OF NEW ZEALAND
Te Pou Rāhui Hanga Hou

In the matter of the Patents Act 1953 and the Regulations thereunder

REC'D 27 JUL 1998
WIPO PCT

AND

In the matter of an application for Letters Patent numbered 329834 in the name of POWER BEAT INTERANATIONAL LIMITED.

NZ 98/98

CERTIFICATE

I hereby certify that the annexed is a true copy of the Provisional Specification as filed on 24 February 1998 with an application for Letters Patent numbered 329834 made by POWER BEAT INTERANATIONAL LIMITED.

This certificate is issued in support of an application for Patent registration in a country outside New Zealand.

AS WITNESS MY HAND this 14th day of July 1998.

Neville Harris

Neville Harris
Commissioner of Patents

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

329834

PATENTS FORM NO. 4
Appln Fee: $80.00
James & Wells Ref: 14148/16 CJ

PATENTS ACT 1953

PROVISIONAL SPECIFICATION

IMPROVED DISPLAY

I POWER BEAT INTERNATIONAL LIMITED a New Zealand company of Airport Road, RD2, Hamilton, New Zealand

do hereby declare this invention to be described in the following statement:

RECEIVED
Intellectual Property Office
24 FEB 1998
of New Zealand

IMPROVED DISPLAY

TECHNICAL FIELD

This invention relates to improvements in displays.

Specifically the present invention will be described for use in liquid crystal display screens. However, it should be appreciated by those skilled in the art that other applications may be considered and reference to liquid crystal displays only should no way be seen as limiting.

BACKGROUND ART

Liquid crystal displays are popular types of display screens. They are commonly used as display screens for laptop computers, where the size and weight of the screen and associated computer is important. Smaller size liquid crystal displays are also well known in numerous applications other than computer screen displays.

A liquid crystal display is in simple terms constructed from four layers of material and a large number of liquid crystals. Normally a display is formed firstly by placing a polariser on one surface of an alignment layer. Liquid crystals are placed between the first alignment layer and a second alignment layer used to retain liquid crystals in place. Lastly, a second polariser is placed on the remaining outside surface of the second alignment layer.

When the screen is in use, an electromagnetic field is applied to selected regions of the liquid crystal held within the alignment layers.

Under normal conditions unpolarised light is projected at the first polariser. Polarised light is transmitted through the first polariser into the first alignment layer. Next this polarised light is transmitted through the liquid crystals of the display.

The liquid crystals used are optically active and will twist the polarised light through a set angle. The alignment layers used ensure the liquid crystals sit at approximately the same orientation, providing light transmitted through the crystals with the same twist or deviation.

Lastly, the twisted polarised light is transmitted through the last polarising layer. The last polariser is configured so as only to allow light polarised at a particular angle to be transmitted through out the front of the display. This specific polarising angle is the angle at which light is normally twisted to by the liquid crystals.

When an electromagnetic field is applied to a region containing liquid crystals, the field causes these crystals to turn to a new orientation. Polarised light hitting the newly orientated crystals will be twisted through a different angle, and hence will not be transmitted through the last polariser.

In this manner a selectively applied electromagnetic field causes light to be transmitted through certain regions of a display and absorbed by certain regions of a display, hence creating a display surface which may be electronically controlled. Modern liquid crystal displays have improved on this basic description by adding coloured filters so colours other than white or black may be displayed.

However, due to the design of such liquid crystal or LC displays, the image presented contains a number of faults.

The use of the two polarisers in a standard LC display significantly cuts down the angles from which the display may be viewed and a well-resolved image observed. If viewed from a wide angle images tend to lose cohesion when compared to the images viewed from directly in front of the display.

The use of the two polarisers in standard LC displays also significantly cuts down the amount of light transmitted through the display. In most instances a strong

background light source must be used to ensure that enough light is transmitted through the display to illuminate images for an observer.

The use of the two polarisers in the construction of the above LC display also increases the manufacturing time and cost for such a device. Extra time and money is required to apply the polarising layers to opposite sides of a display.

The applicants have also found standard liquid crystal displays to be deficient when applied in deep video imaging technology. Deep video imaging technology is the subject of co-pending New Zealand Patent Application Nos. NZ314566, NZ328074 and NZ329130.

Deep video imaging relates to a new method and apparatus for displaying images. A "deep" video image is formed by two or more display screens combined together so that an observer may see an image on the first screen closest to them as well as an image on a second screen behind the first screen. The view seen by an observer may be defined as a 'composite image', which is formed from images displayed on each of the screens. Because of the physical displacement between the display screens used, the composite image observed will seem to be three-dimensional. An image on a front screen can recede onto a rear screen and vice versa, creating the illusion of depth.

The applicants have found that liquid crystal displays may be used in deep video imaging applications. A rear screen may be formed from a LC display which includes a backlighting light source behind the display. A second LC display may be positioned in front of the rear display and will not include backlighting components, as these would interfere with light transmitted from a rear screen. In effect, the front screen is substantially transparent, allowing light to be transmitted from the rear screen to the eyes of an observer.

During development of deep video imaging technology, the applicants have found the use of combined liquid crystal displays creates a number of faults in the composite image viewed.

Images created on a front screen will always be transparent. An observer will be able to look through the front screen (and hence foreground images) onto the rear screen.

Combining two LC displays together in front of an observer creates interference patterns on the face of the displays. The regular structure associated with the alignment layers of each LC display sets up a pattern in the light transmitted, with the combination of the two patterns creating interference effects.

Deep video imaging using standard LC displays also suffers from viewing angle problems. An observer at a wide angle from the centre of the display will observe images on the front and rear screens in different positions than an observer viewing the display front on. To provide an observer with a "3D" effect from the display one image processing technique considered is to gradually reduce in size a front screen image and then transfer this image to the rear screen, giving the illusion that the image is moving backwards.

However, this processing technique poses problems when the display is viewed from a wide angle. When the image from the front screen is transferred to the rear screen, the point at which the image appears to be travelling to on the rear screen, as seen by an observer directly in front of the display is different to that seen by an observer off at an angle. When the front image is transferred to the rear screen an observer out of a wide angle will see the image jump or flick to a new position, ruining the illusion that the front screen image is receding.

An improved display, which solved any or all of the above problems, would be of great advantage over the prior art.

It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

Further aspects and advantages of the present invention will become apparent from the ensuing description, which is given by way of example only.

DISCLOSURE OF INVENTION

According to one aspect of the present invention there is provided a display which includes at least two retainer layers, and

at least one optically active element,

wherein retainer layers are configured to retain active elements in an irregular configuration in a first instance, and

in a regular configuration in the second instance.

According to a further aspect of the present invention there is provided a retainer layer adapted for use in a display as described above, wherein the retainer layer is configured to retain optically active elements in irregular orientations.

According to yet another aspect of the present invention there is provided a method of operating display substantially as described above wherein the method is characterised by the steps of:

(a) selectively applying a field to a first region containing at least two active elements, and

(b) aligning active elements within said first region with each other to have substantially the same orientation, and

(c) transmitting light through the first region so that the light exhibits a first characteristic, and

(d) transmitting light through regions other than the first region so that the transmitted light exhibits a second characteristic.

In a preferred embodiment a display configured with respect to the present invention may be any type of device which can transmit or pass modified light patterns to an observer.

In a further preferred embodiment the display may be configured using liquid crystal display technology.

Reference for other specifications shall now be made to the display as being a device which uses liquid crystal technology. However, it should be appreciated by those skilled in the art that other forms of display may be used in conjunction with the present invention and reference to the liquid crystal technology only should in no way be seen as limiting.

In a preferred embodiment a retainer layer may be any type of substantially transparent material which, when configured in groups of two or more layers, may retain optically active elements in a particular region.

In a further preferred embodiment a retainer layer may be formed from transparent plastic materials with an irregular surface on one side of the layer. Such an irregular surface allows optically active elements to be retained within regions on the retainer layer in a large number of orientations, providing retained active elements with an irregular configuration.

In a further preferred embodiment a retainer layer may be constructed from transparent plastic material with small irregular gouges made on one surface of the layer. These irregular gouges allow active elements retained by the layer to lie in a number of different orientations in an irregular configuration.

Reference throughout this specification shall now be made to a retainer layer as being constructed from a transparent plastic material with irregular surface gouges on one surface of the layer. However, it should be appreciated by those skilled in the art that other types of retainer layer may be used in conjunction with the present invention, and reference to the above should in no way be seen as limiting.

In a preferred embodiment optically active elements may be liquid crystals normally used in a standard liquid crystal display. The properties and characteristics of these crystals are well known and allow them to be readily adapted for use with the present invention.

Alternative embodiments may not use standard liquid crystals as optically active elements. Other embodiments may employ any type of optically active material, the optical properties of which can be readily controlled and manipulated.

Reference throughout this specification shall now be made to optically elements as being liquid crystals. However, it should be appreciated by those skilled in the art that other forms of optically active elements may be used and reference to the above should in no way be seen as limiting.

In a preferred embodiment liquid crystals may be grouped or organised in two different configurations.

In a first instance liquid crystals may be retained between two retainer layers with an irregular or randomised configuration. The surface of a retainer layer may be configured so as to allow retained crystals to lie in a large number of orientations or angles with respect to one another.

In a second instance crystals may be retained between retainer layers in a regular configuration. In a preferred embodiment crystals may be retained in substantially the same angles and orientations with respect to one another. This regular configuration of

the crystals ensures that each crystal acts optically in substantially the same manner on light passing through the crystals.

In a preferred embodiment a field is applied to crystals within a display to orient the crystals within the field into substantially the same or orientation.

In a further preferred embodiment the field used is an electromagnetic field. Electromagnetic fields may be readily generated using standard electrical componentry and may control accurately and precisely small areas or regions containing crystals.

In a preferred embodiment a first region containing at least two liquid crystals may be any number of areas or points on the viewing surface of a display. Further, in embodiments where the present invention is used in a multiple screen display, as with the video imaging technology, a region may incorporate display surface areas from any of the multiple screens used.

In a further preferred embodiment a first region may be defined as any area on a display to which an electromagnetic field is applied.

In such an embodiment an electromagnetic field may be selectively applied to particular areas of a display to form a first region. The application of an electromagnetic field to particular areas will cause crystals to orientate to substantially the same position, and hence to modify incident light with substantially the same effect. However, in regions other than the first region where no electromagnetic field is applied, no regular or uniform treatment will be applied to incident light.

In a preferred embodiment crystals within a first region exhibit a first optical characteristic. Conversely crystals outside this first region exhibit a second optical characteristic.

In a further preferred embodiment the first optical characteristic exhibited by crystals within the first region is transparency. Such crystals may be regularly positioned with

respect to one another into substantially the same orientations. This regular configuration allows crystals to transmit incident light in substantially the same manner, with these crystals being transparent to a particular polarisation of light.

In a further preferred embodiment the second optical characteristic exhibited by crystals outside of the first region is to act as diffusing elements. The irregular and random orientations of crystals outside of a first region diffuses light transmitted through the display.

A diffusing element may be defined as any element which diffuses light. Such an element may cause light to spread or scatter in a number of different directions.

Such diffusing elements will make any image viewed on the first region appear diffuse to an observer relatively close to the screen, and the same image appear opaque to an observer at a greater distance away from the screen. As the distance between an observer and the screen increases an image in the first region will appear more and more opaque instead of diffuse.

As can be appreciated by those skilled in the art the irregular configurations of liquid crystals will act to diffuse light transmitted through the display when no electromagnetic field is present. Conversely, when an electromagnetic field is applied to a region the crystals present are forced into substantially the same orientation, allowing light to be transmitted through the region without being substantially diffused.

The present invention as described above may be used to construct a simple display.

Transparent electrodes may be placed on either face of the display to selectively apply an electromagnetic field to specific areas forming a first region. This electromagnetic field, or the absence of it, will either allow light to be transmitted through a particular region or to be diffused when passing through another region. Images may be formed

on such a display by placing an electromagnetic field on regions which are to be transparent whilst ensuring no electromagnetic field is present on regions which are to form images. Colour filters from standard LC displays may also be used in such a display to provide extra colour to the diffused region.

The present invention also allows the colour white to be presented on a display. Normally LC displays cannot display a sharp white colour. To display white on the typical LC display the white backlighting background is used, as crystals are orientated to be transparent in this instance.

This is in contrast to the present invention where sharp white colour may be obtained simply by diffusing light transmitted through selected regions of the display.

The applicants have also trialed the present invention in deep video imaging applications.

In deep video imaging applications a composite image may be formed by the use of two liquid crystal displays, with one display being placed in front of the other and the rear display including the required backlighting components. Separate and distinct images may be observed on each screen, with the spatial displacement between the two screens providing the composite images with three-dimensional qualities.

In one embodiment the present invention may be employed within a deep video display.

Reference throughout the specification shall now be made to a display formed with respect to the present invention as being a selective diffusion layer when used in deep video imaging applications. As discussed above, the present invention may be employed to selectively diffuse regions on a display, while leaving other regions transparent.

A deep video display which incorporates two liquid crystal screens may also use three polarising layers only. The first polarising layer may be positioned at the rear of the rear screen, the second between the two screens and the last on the front of the front screen. In normal LC displays two polarising layers per screen are required, as polarised light must be provided to the liquid crystals to ensure the display works effectively. However, in a deep video application, with two LC displays, polarised light is already provided to the rear of a front screen, eliminating the need for a fourth polariser in the combined display.

In a preferred embodiment the selective diffusion layer may be positioned between the front and rear screens of a deep video display.

In a further preferred embodiment a deep video display may be configured as described above with three polarising layers. A selective diffusion layer (SDL) may also be positioned between the front screen and the middle polarising layer. The SDL may be used to diffuse polarised light supplied from the middle polarising layer, destroying the front screens capacity to form an image in a particular region. This in effect allows the SDL to "blank out" a front image.

A deep video display configured with an SDL as discussed above may create the illusion that an image from a front screen disappears or recedes on to a rear screen at exactly the same point for all observers irrespective of viewing angles.

Previously, in deep video imaging applications an image transferred from a front screen to a rear screen would appear to jump sideways for an observer out at an angle, to the display and recede smoothly for an observer in front of the display. This effect is eliminated with the use of an SDL configured as discussed above. The SDL ensures that a front image is transferred to the rear screen at exactly the same point on the rear screen for all observers, eliminating the sideways jump previously observed at an angle out from the centre of the display.

In yet another embodiment of the present invention a selective diffusion layer may be positioned between two LC displays, this time with polarising layers behind and in front of each LC display. The selective diffusion layer may be positioned in front of the rear screens front polariser and behind the front screens rear polariser.

The selective diffusion layer may be used to diffuse polarised light from a rear screen, making an image on a front screen appear opaque. The selective diffusion layer will diffuse out the rear image while still providing enough light to illuminate a front image. Previously, in deep video imaging displays without selective diffusion layers, images on a front screen have appeared transparent, where images on a rear screen can be seen through a front image. With the use of a selective diffusion layer, images from a rear screen may be "blanked out" by the selective diffusion layer (SDL), making the front images appear opaque.

In yet another embodiment a combination of polarising and selecting diffusion layers may be employed to provide a deep video imaging display with three display screens. In such an application the polarising and selective diffusion layers may be configured to provide opaque images on a front screen, and images on a middle screen which recede and are transferred onto the same point on a rear screen for all observers of the display.

In such an embodiment the display may be configured with a first polarising layer, a rear LC screen, a second polarising layer, a first selective diffusion layer, a second LC display, a third polarising layer, a second selective diffusion layer, a fourth polarising layer, a third front LC display and lastly a fifth polarising layer. Such a deep video display combines principles employed in the two other deep video applications discussed above.

The second SDL will diffuse light transmitted from the rear and middle screens, making images on the front screen appear opaque. The first SDL will diffuse light

transmitted to the second LC display, allowing an image from the second LC display to disappear at the same point on the rear LC display for all observers as discussed above.

A selective diffusion layer may also be used in deep video applications to eliminate interference effects. Normally when a standard LC display is viewed through another LC display interference patterns caused by the structure of the two displays will be observed.

Interference patterns can be eliminated with an SDL between two screens if the SDL provides a low uniform level of diffusion over the entire display surface. The diffusion will act to randomise or break up any patterns in light from a rear screen – removing interference effects.

The present invention provides many advantages over existing prior art liquid crystal displays and deep video imaging displays.

The present invention may be employed in deep video imaging applications to create a display with foreground images which appear opaque and which can be made to appear to recede on to the same point on a rear screen irrespective of viewing angle.

BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1	shows the displays effect on light within specific regions in one embodiment; and
Figures 2-4	illustrate the present invention as employed in deep video imaging applications in further embodiments of the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

Figure 1 shows how the present invention modifies light transmitted through a display. In Figure 1a an electromagnetic field is applied to a region of a display, whereas in Figure 1b no electromagnetic field is applied to the same region.

In both cases unpolarised light 1 is directed towards a rear alignment layer 2 through the liquid crystals (not shown) retained within the region, and then out through the front alignment layer 3.

In Figure 1a an electromagnetic field is applied to the region. The liquid crystals within this region align with substantially the same orientation, allowing the incident unpolarised light 1 to pass through the crystals and out through the front alignment layer 3. The output from this screen 5 is substantially the same as the incident light 1.

This can be contrasted with light passed through the region when an electromagnetic field is not present, as in the case of Figure 1b. In this instance the liquid crystals between the two alignment layers 2, 3 create diffused light 6 from the incident non-polarised light 1. This diffused light 6 is then passed out through the front alignment layer 3 as the display output 7.

As can be seen from the diagrams, the application of an electromagnetic field within a region will make the liquid crystals substantially transparent to incident light. The absence of an electromagnetic field in a region will cause the light transmitted to be diffused.

Figures 2 to 4 illustrate the present invention when used in a number of deep video imaging applications.

Figure 2 shows a deep video imaging application which incorporates a selective diffusion layer d1. The deep video imaging display includes a rear screen s1 and front

screen s2 with polarising layers p1, p2 on either side of the rear screen s1, and polarising layers p3, p4 on either side of the front screen s2.

The selective diffusion layer or SDL, d1 is placed in between polarising layers p2 and p3. The SDL d1 diffuses polarised light from polariser p2, destroying images presented on rear screen s1. This effect makes an image on front screen s2 appear opaque, as now only diffused background light is provided behind s2's image.

Figure 3 illustrates another application for the present invention in a deep video-imaging application. In this embodiment the deep video imaging screen includes a rear screen s1 a front screen s2, polarising layers p1 and p2 on either side of the rear screen s1, and a last polarising layer p3 on the front of the front screen s2. An SDL d1 is positioned between polarising layer p2 and the front screen s2.

The SDL d1 may diffuse the polarised light provided by polariser p2. Depolarising the background light for front screen s2 will prevent s2 from forming a coherent image. The SLD d1 may be used to "blank out" an image on the front screen s2. This phenomenon can be utilised as discussed above to make an image on a front screen disappear at the same point on a rear screen for all observers, independent of viewing angle.

Figure 4 shows a deep video imaging display that uses the two configurations previously discussed with respect to Figures 2 and 3.

The selective diffusion layer d2 may be used to diffuse light and images from rear screen s1 and middle screen s2, making images on the front screen s3 appear opaque.

Selective diffusion layer d1 may be used to diffuse polarised light from polarising layer p2, "blanking out" images on middle screen s2.

329834

This display configuration using the present invention may be used to make images on a front screen s3 appear opaque, and images on middle screen s2 disappear onto the rear screen S1 at the same point for all observers irrespective of viewing angles.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof.

POWER BEAT INTERNATIONAL LIMITED

by his Attorney(s)

JAMES & WELLS

RECEIVED
Intellectual Property Office

24 FEB 1998

of New Zealand

Figure 1a

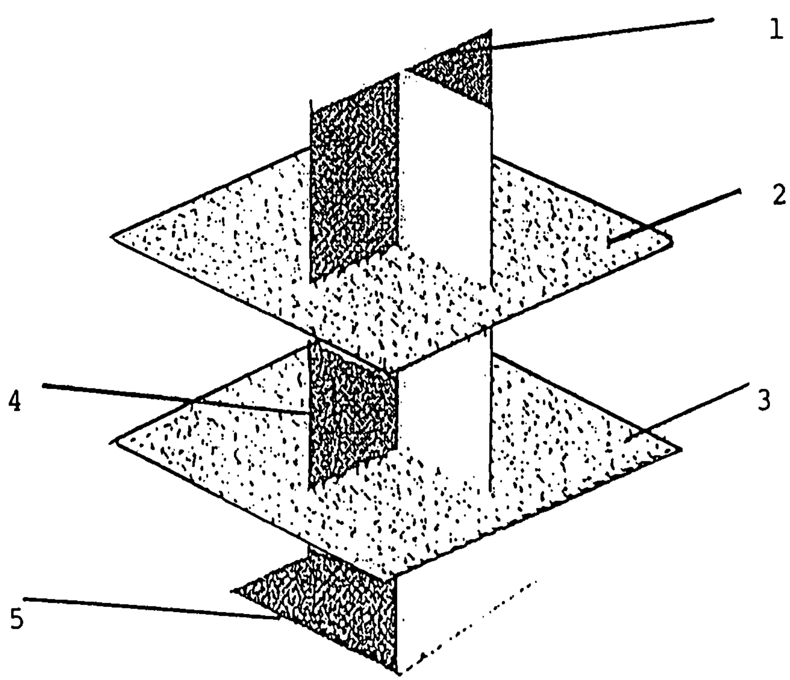

Figure 1b

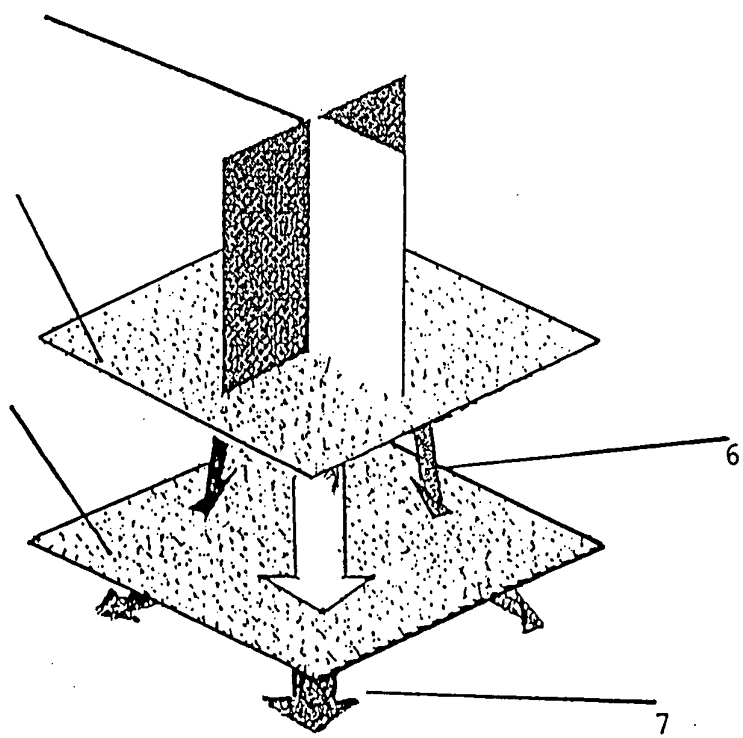

Fig. 2

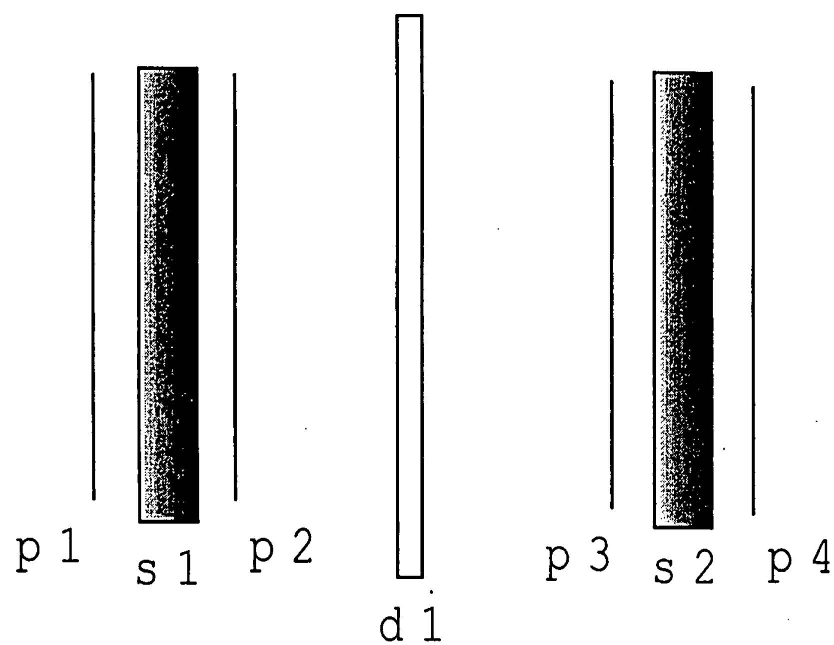

Fig. 3

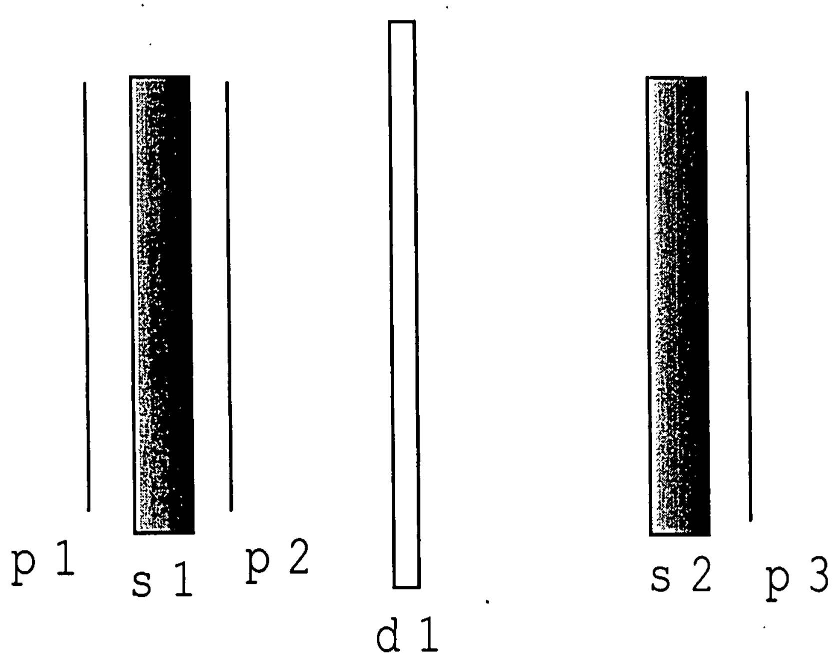

Fig. 4